

WHAT IS CLAIMED IS:

1. A diffractive optical element made of at least two materials of different dispersions, and including at least two diffraction gratings being accumulated one upon another, characterized in that:

each diffraction grating is formed on a curved surface of a substrate; and that a diffraction grating, of said at least two diffraction gratings, in which a curvature radius of the curved surface and a curvature radius of a grating surface in a portion where a grating pitch is largest, have different signs, is one of said at least two diffraction gratings which has a smallest grating thickness.

2. A diffractive optical element according to Claim 1, wherein said diffraction grating having a smallest grating thickness is structured so that an angle which is defined between the grating surface and a grating edge of that diffraction grating is obtuse more than an angle which is defined between the grating surface and a normal to the surface at a position where a plane connecting grating free ends of the smallest-thickness diffraction grating and the grating surface intersect with each other.

3. A diffractive optical element according to Claim 1 or 2, wherein the grating edge of the diffraction grating is made in parallel to an optical axis.

4. A diffractive optical element according to Claim 2 or 3, wherein the curvature of the plane connecting the grating free ends is approximately even, in each diffraction grating of said at least two accumulated diffraction gratings.

5. A diffractive optical element according to any one of Claims 1 - 4, wherein at least one of said at least two diffraction gratings is formed at an interface of two different materials having different dispersions.

6. A diffractive optical element according to any one of Claims 1 - 5, wherein said at least two accumulated diffraction gratings are bonded with each other in a non-grating region.

7. A diffractive optical element according to any one of Claims 1 - 6, wherein said

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at least two diffraction gratings include at least one grating of a shape in which a direction of the grating thickness is different.

5 8. A diffractive optical element according to any one of Claims 1 - 7, wherein said diffractive optical element is effective to improve a diffraction efficiency of a predetermined order, over a whole visible light
10 region of a used wavelength.

 9. A diffractive optical element according to any one of Claims 1 - 8, wherein there is a wavelength included in the used wavelength
15 range which wavelength satisfies the following relation:

$$\pm (n01-1) d1 \pm (n03-1) d2 \pm (n02-1) d2 = m\lambda_0$$

where n01 is a refractive index of the material of a first diffraction grating with respect to
20 a wavelength λ_0 , n02 is a refractive index of the material of a second diffraction grating with respect to the wavelength λ_0 , n03 is a refractive index of the material of a third diffraction grating with respect to the wavelength λ_0 , d1 and
25 d2 are thicknesses of the first and second diffraction gratings, and m is a diffraction order.

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10. A diffractive optical element according to any one of Claims 1 - 9, wherein the substrate has a lens function.

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11. A diffraction optical system including a diffractive optical element as recited in any one of Claims 1 - 10.

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12. A diffraction optical system according to Claim 11, wherein said optical system is an imaging optical system.

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13. A diffraction optical system according to Claim 12, wherein said diffractive optical element is provided at one of a lens cemented surface and a lens surface, or inside a lens.

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14. A diffraction optical system according to Claim 11, wherein said optical system is an observation optical system.

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15. A diffraction optical system according to Claim 14, wherein said diffractive optical element is provided at a side of a lens, constituting the observation optical system, which faces an objective lens side thereof.

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